



# **Aerobic Vinyl Chloride Biodegradation to Support Anaerobic Chloroethene Reduction**

**Presented By  
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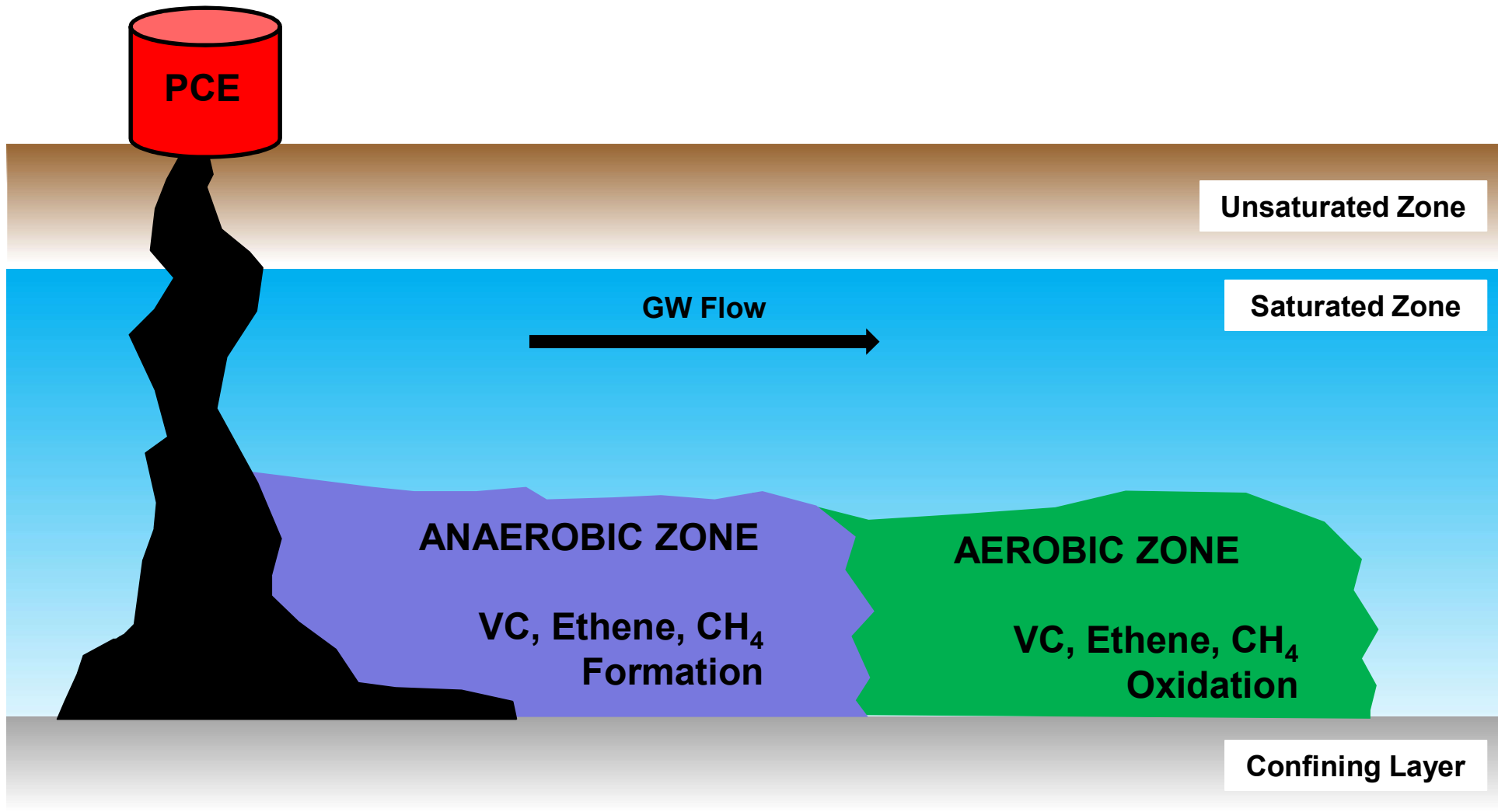
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# Objective



- **Present and overview of aerobic VC biodegradation its potential impact on the attenuation of VC and other cVOCs**

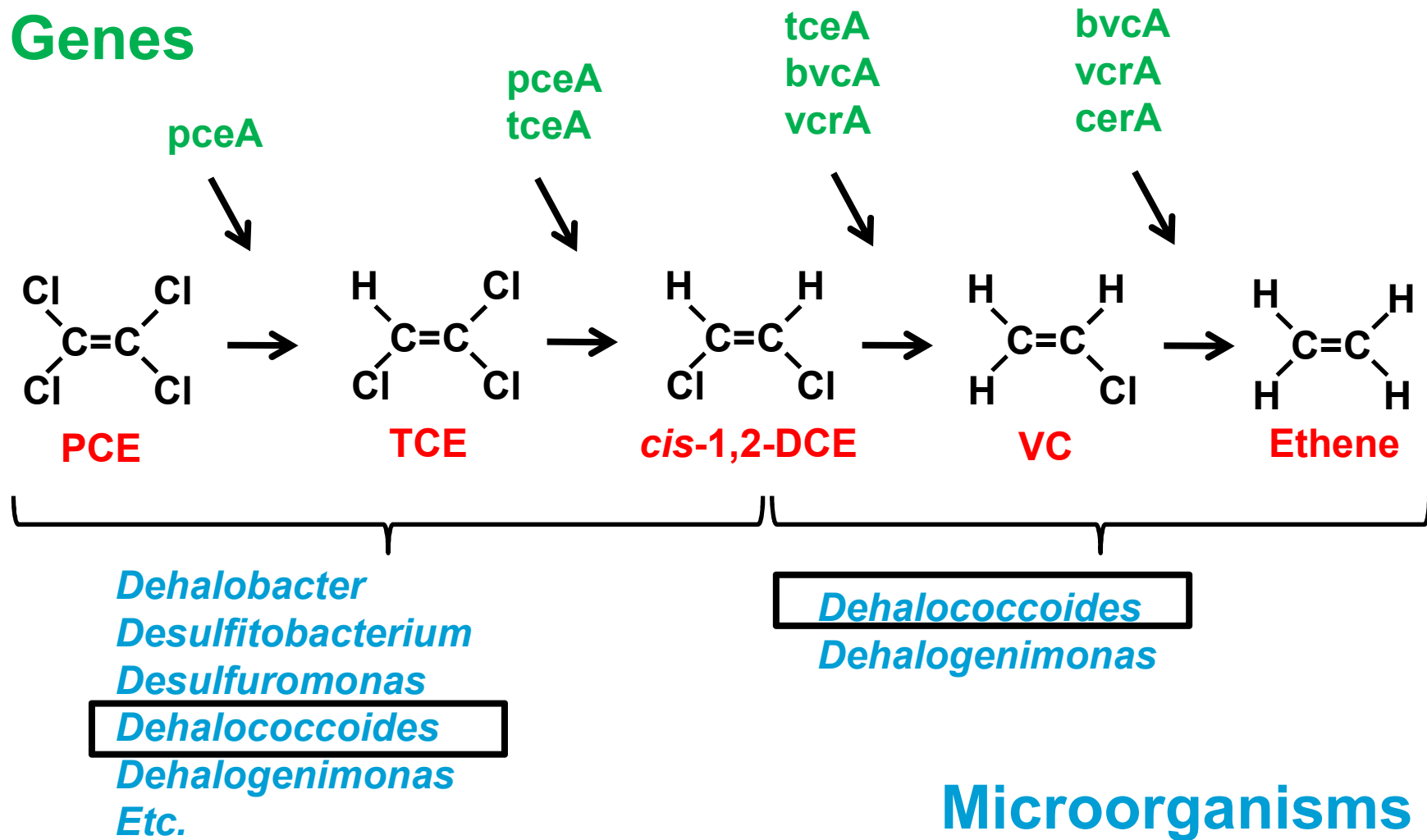
# Conventional CSM for Chloroethenes



# Anaerobic Reductive Dechlorination of Chloroethenes



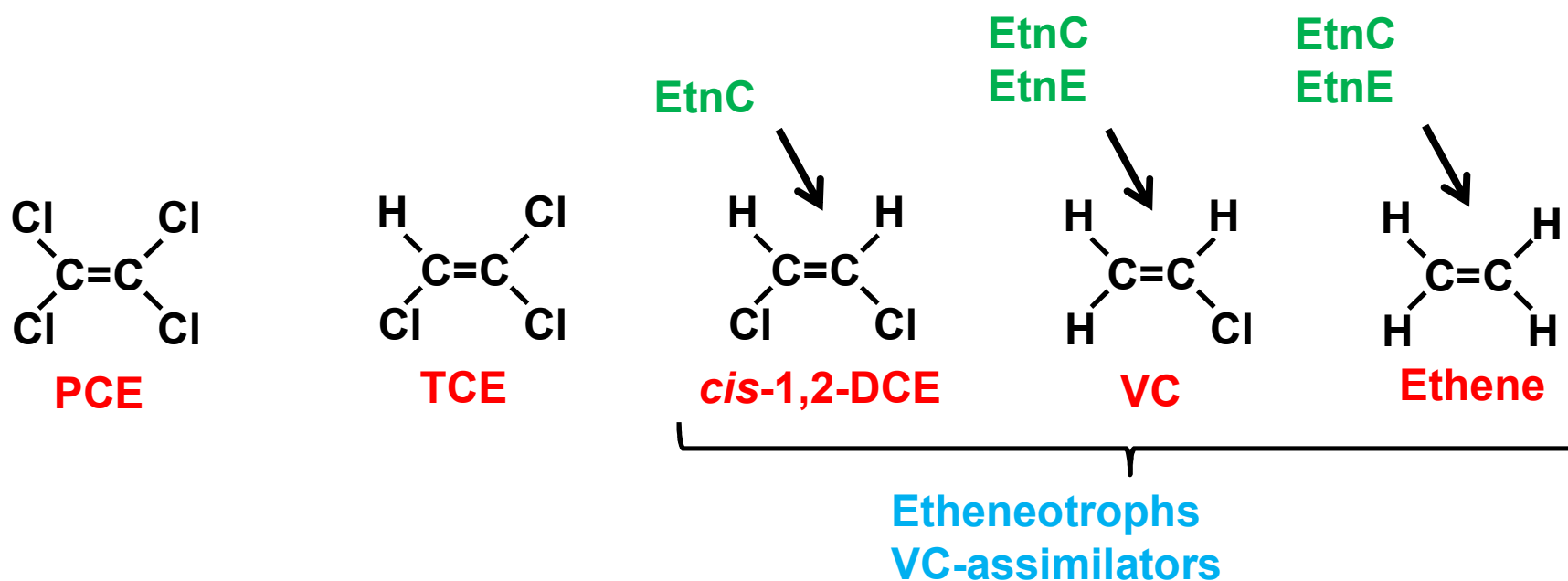
## Genes



# Aerobic Dechlorination Processes



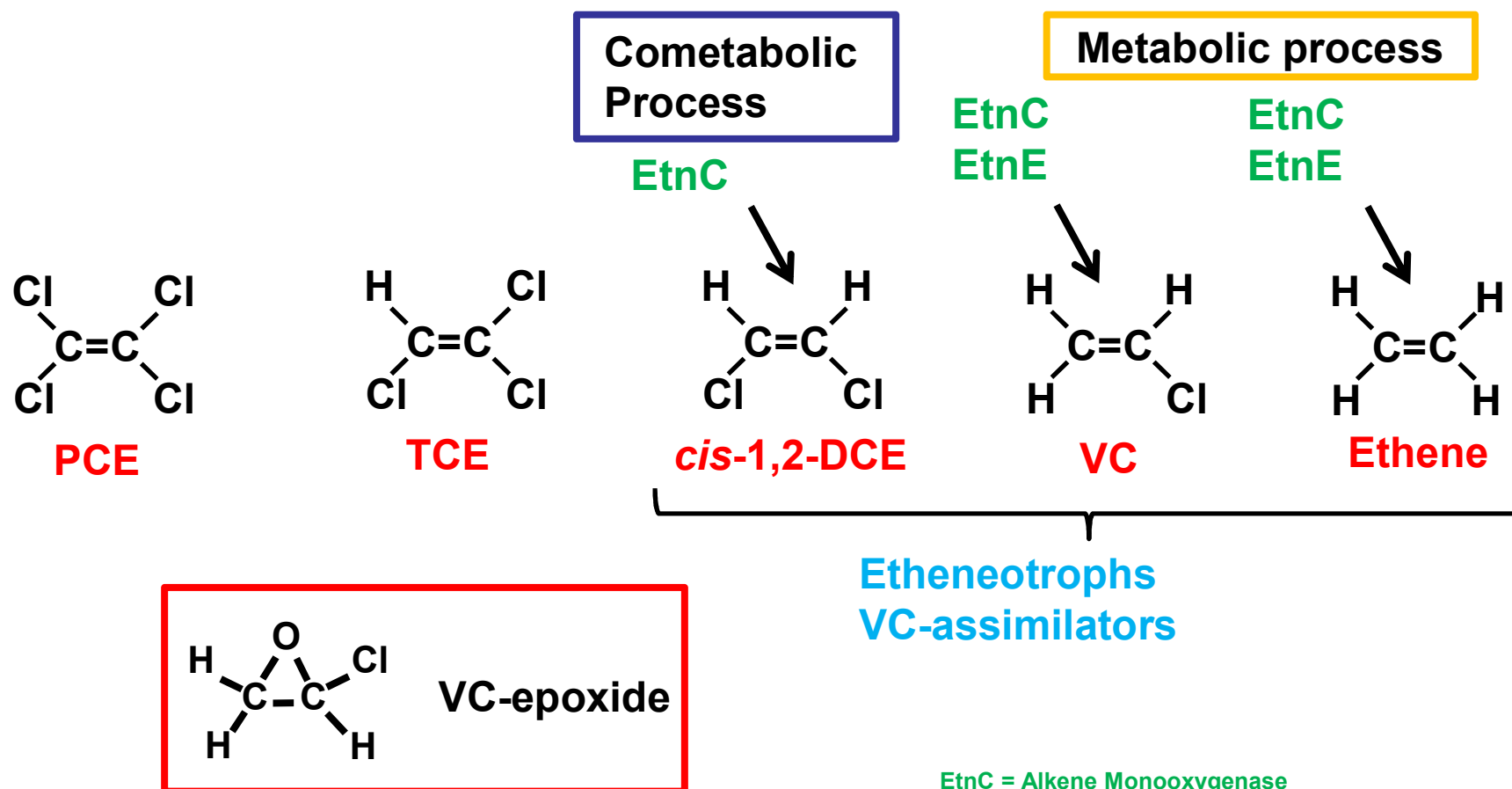
## Genes



EtnC = Alkene Monooxygenase  
EtnE = Epoxyalkane CoM Transferase

# Aerobic Dechlorination Processes

## Genes



EtnC = Alkene Monooxygenase  
EtnE = Epoxyalkane CoM Transferase

# Metabolism versus Cometabolism

## METABOLISM



**Monooxygenases**

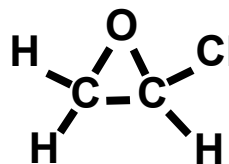
**'Non-specific'**

Can be partial or complete

## COMETABOLISM



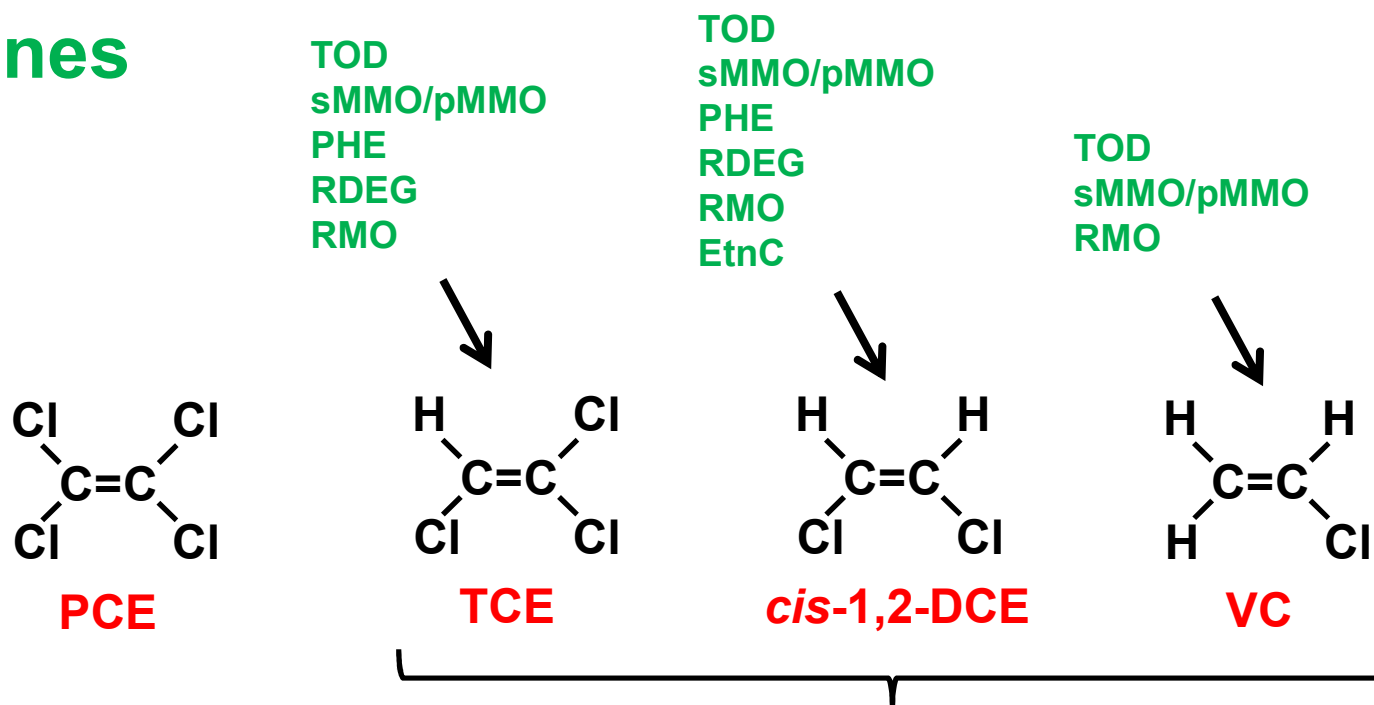
TCE  
cDCE  
VC



TCE-epoxide  
cDCE-epoxide  
VC-epoxide

# Aerobic Dechlorination Processes

## Genes



Propanotrophs  
Methanotrophs  
etc.

TOD = Toluene Dioxygenase  
sMMO/pMMO = soluble/particulate Methane Monooxygenase  
PHE = Phenol Hydroxylase  
RMO = Toluene Monooxygenase  
RDEG 2 = Toluene Monooxygenase  
EtnC = Alkene Monooxygenase

## Microorganisms

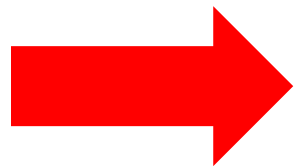


# Anaerobic and Aerobic Degraders

- Previous work at 5 different cVOC sites with different concentrations and biodegradation rates but generally low in DO and ORP

Liang et al., 2017

- Found high concentrations of aerobic VC genes/transcripts (etnC/etnE) + anaerobic VC genes/transcripts (vcrA/bvcA) associated with VC
- Not true with methanotrophs



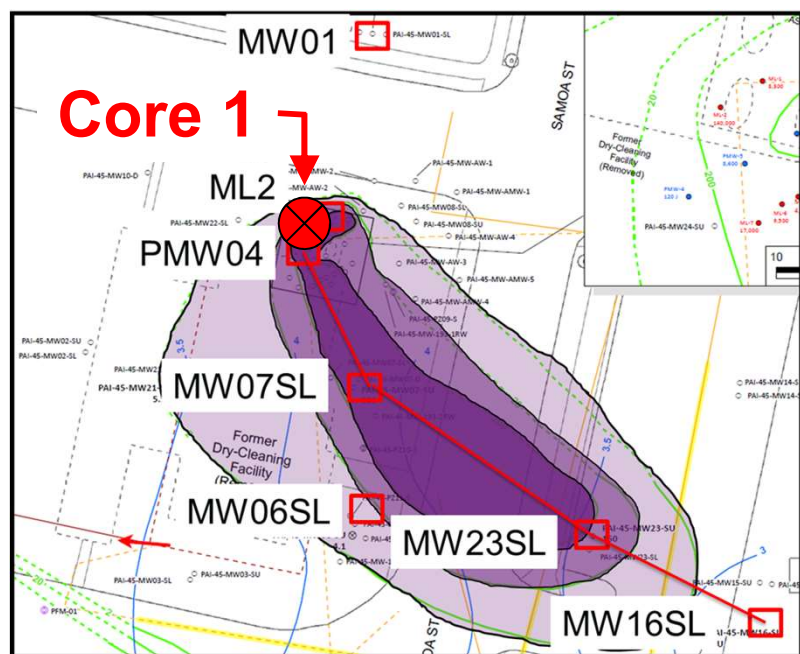
**NOTE:  $K_s$  for  $O_2$  for VC degraders is ~ 0.16 mg/L!**

Coleman et al., 2002

# Anaerobic and Aerobic Degraders



## cVOC site

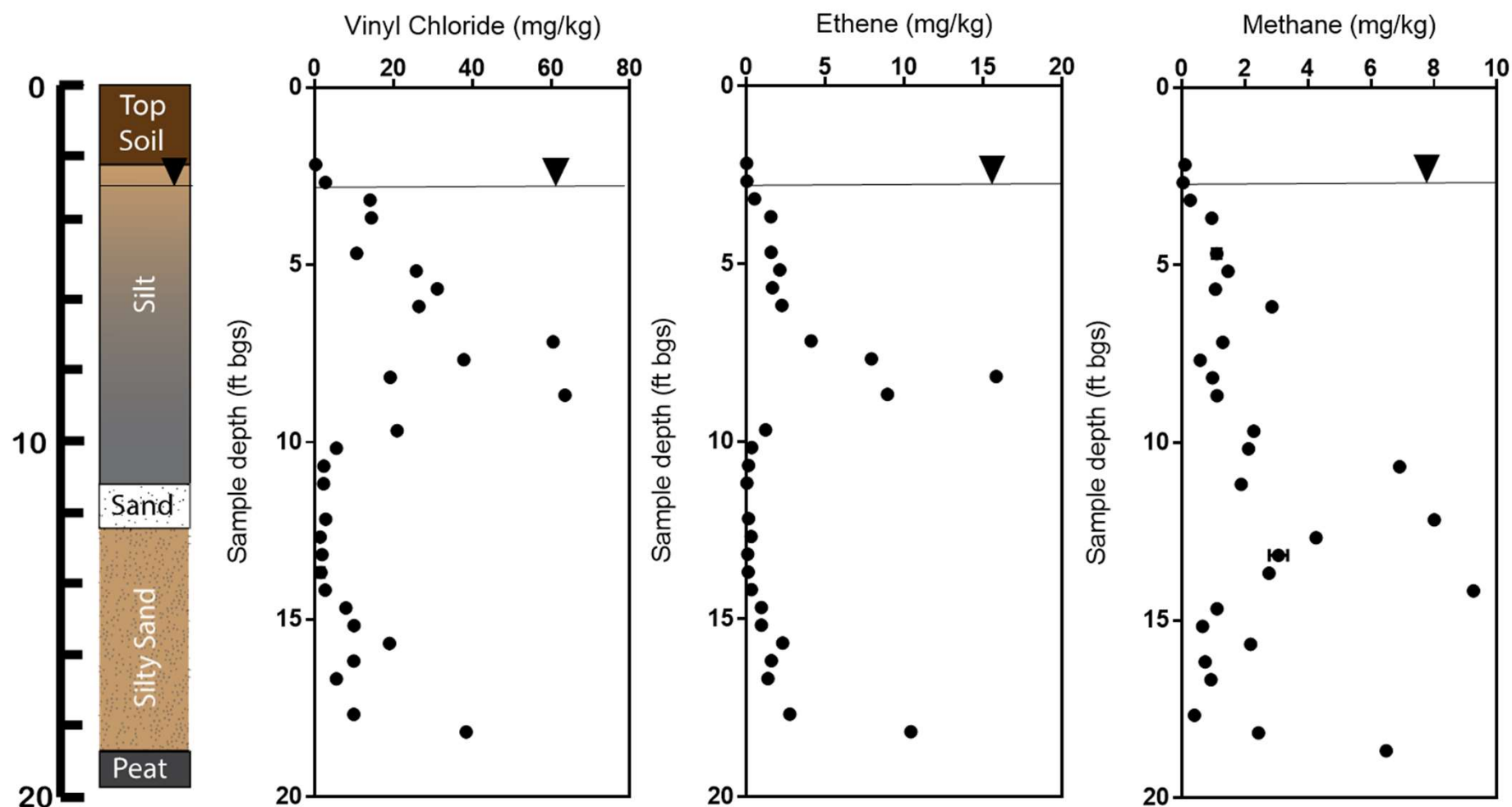


Parameter	Avg. sample (39) concentrations
<i>PCE + TCE</i>	292 µg/L
<i>cDCE</i>	2651 µg/L
<i>VC</i>	1938 µg/L
<i>Ethene</i>	218 µg/L
<i>Methane</i>	2621 µg/L
<i>DO</i>	0.74 mg/L
<i>ORP</i>	15 mV

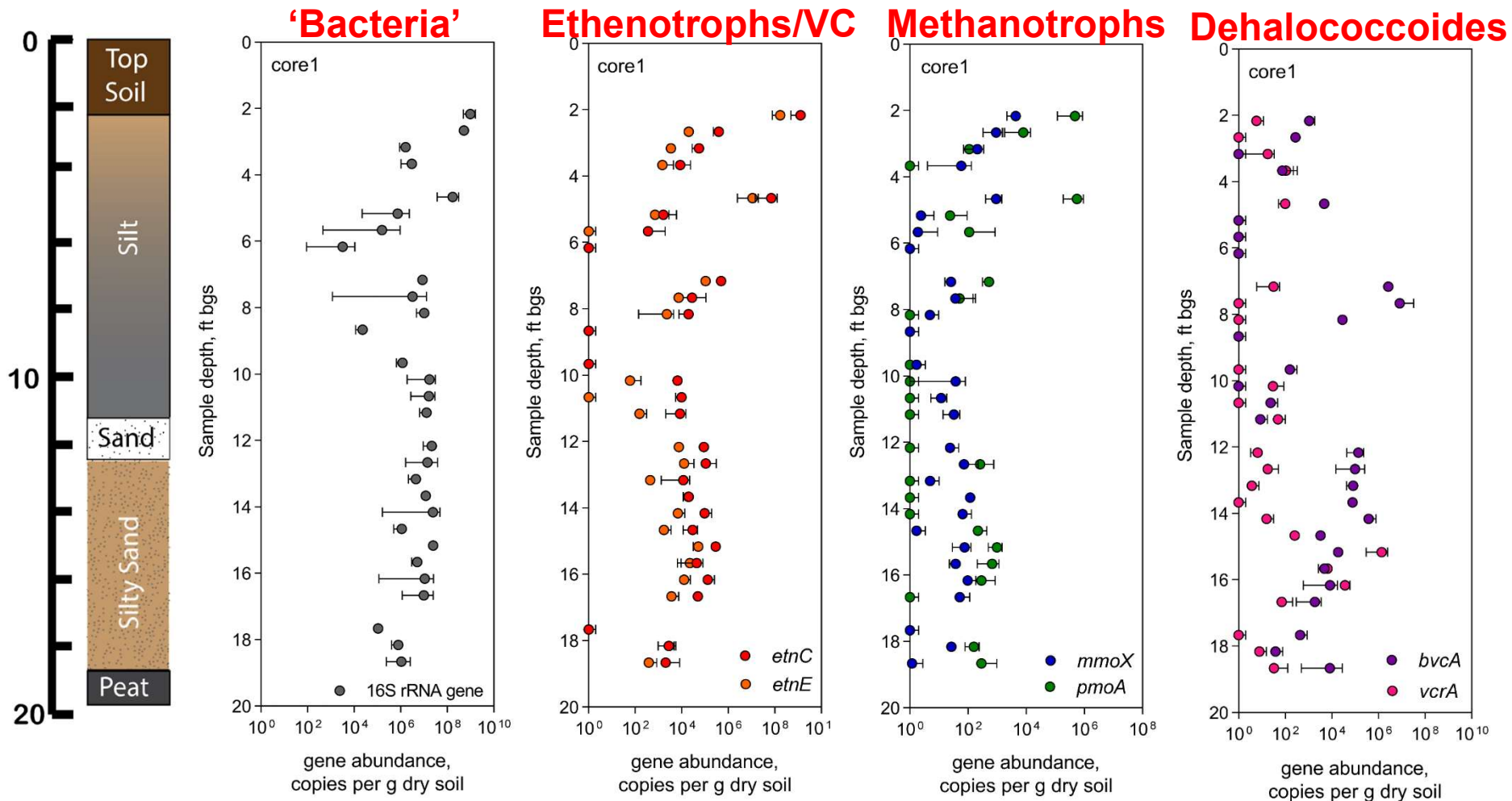
## Cryocore sampling



# Gas Concentrations



# Anaerobic and Aerobic Degraders



# Knowledge Check



- **Biotransformation of VC only occurs via anaerobic processes (Dehalococcoides)**

☐

**TRUE**

☐

**FALSE**

- **A variety of primary substrates can be present at a site that can drive cometabolism**

☐

**TRUE**

☐

**FALSE**

# Summary



- **Both anaerobic and aerobic processes are able to degrade chloroethenes at sites**
- **Aerobic microorganisms are active in anaerobic zones**
- **Both metabolic and cometabolic processes may be important**
- **Biomarkers are available to measure the potential for anaerobic and aerobic activity**
- **Data should be integrated into existing site data**

# Contacts and Questions



## Points of Contact

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## Questions ?

# Supplemental Information



## **Advances in Microbial Characterization for MNA & Bioremediation (Open Environmental Restoration Resources (OER2) Webinar):**

[https://www.navfac.navy.mil/navfac\\_worldwide/specialty\\_centers/exwc/products\\_and\\_services/ev/erb/oer2.html](https://www.navfac.navy.mil/navfac_worldwide/specialty_centers/exwc/products_and_services/ev/erb/oer2.html)



## **Relationships between the Abundance and Expression of Functional Genes from Vinyl Chloride (VC)-Degrading Bacteria and Geochemical Parameters at VC-Contaminated Sites**

Y. Liang, X. Liu, M. Singletary, K. Wang, and T. E. Mattes

<https://pubs.acs.org/doi/10.1021/acs.est.7b03521>

## **NAVFAC Environmental Restoration and BRAC Website**

—————→ Chlorinated Solvents

[https://www.navfac.navy.mil/navfac\\_worldwide/specialty\\_centers/exwc/products\\_and\\_services/ev/erb/chlor-solv.html#resources](https://www.navfac.navy.mil/navfac_worldwide/specialty_centers/exwc/products_and_services/ev/erb/chlor-solv.html#resources)